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DEVICE FOR LIMITING MOVEMENT OF A BODY IN RELATION TO ANOTHER

FIELD OF THE INVENTION

The present invention relates generally to movement mechanisms and more particularly to devices for limiting the movement of a body in relation to another.

BACKGROUND OF THE INVENTION

In some applications, it is often desirable to provide a user access to the contents of a container such as a drawer but, for safety and other reasons, not permit him to completely remove the container from its assigned slot without releasing an interlock. One example of many such applications occurs in magnetic tape libraries. Tape libraries are used in computer systems as a convenient means of storage and retrieval of large amounts of data. The data is stored on magnetic tape with each tape mounted in a holder. The combined tape and holder are referred to as a tape cartridge. The tape cartridges are loaded onto trays within the tape library for storage and subsequent selection. When data from a particular tape is required, the tray on which its cartridge is stored is moved by a magnetic tape autochanger, which is a component of the tape library, to the vicinity of a magnetic tape reader. The tape cartridge is removed from its tray and positioned in the tape reader where its data is then read by the tape reader.

In such systems, it is typically necessary to provide the user access to the tape cartridges for cartridge loading and unloading. As an example, individual cartridges or groups of cartridges may need to be removed from the autochanger as they wear-out or, for data safety, stored off-site.

In typical systems, when a user desires to add or remove a particular cartridge he does so by first requesting it via either the front panel of the autochanger or the host

computer. The autochanger then moves the tray on which the selected cartridge resides to a special drawer, typically referred to as a mailbox, that the autochanger uses for such access. The system then actuates a solenoid so that the drawer can be partially opened thereby providing access to the cartridge.

An interlock is provided to inhibit complete removal of the drawer. For complete removal of the drawer, the interlock is first released. In typical autochangers this interlock comprises an expensive panel and/or computer-actuated solenoid.

SUMMARY OF THE INVENTION

In one embodiment, a device for limiting the movement of a first body in relation to a second body is disclosed which includes a bendable piece of material, wherein the piece includes a first section and a second section contiguous to the first section, wherein the second section forms a first angle with respect to the first section, wherein the first angle is measured in a counter-clockwise direction from the first section, wherein the first angle is at least zero degrees and is less than 135 degrees when the piece is un-deflected, and wherein at least a portion of the first section is attachable to the second body.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings provide visual representations which will be used to more fully describe the invention and can be used by those skilled in the art to better understand it and its inherent advantages. In these drawings, like reference numerals identify corresponding elements and:

Figure 1A is a drawing of a device for limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention.

Figure 1B is a drawing of the device of figure 1A located in a first position for

limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention.

Figure 1C is another drawing of the device of figure 1A located in a second position for limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention.

Figure 1D is a drawing of another embodiment of the device of figure 1A for limiting the movement of one body in relation to another with minimum value of first angle consistent with the teachings of the invention.

Figure 2A is a drawing of another embodiment of the device for limiting the movement of one body in relation to another consistent with the teachings of the invention.

Figure 2B is a drawing of the device of figure 2A located in the first position for limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention.

Figure 2C is another drawing of the device of figure 2A located in the second position for limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention.

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Figure 2D is a drawing of ~~another~~ another embodiment of the device of figure 2A for limiting the movement of one body in relation to another with minimum value of first angle consistent with the teachings of the invention.

Figure 3A is a drawing of a further embodiment of the device for limiting the movement of one body in relation to another consistent with the teachings of the invention.

Figure 3B is a drawing of the device of figure 3A located in the first position for limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention.

Figure 3C is another drawing of the device of figure 3A located in the second position for limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention.

Figure 4A is drawing of still another embodiment of the device for limiting the

movement of one body in relation to another consistent with the teachings of the invention.

Figure 4B is a drawing of the device of figure 4A located in the first position for limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention.

Figure 4C is another drawing of the device of figure 4A located in the second position for limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention.

Figure 5 is a drawing of an example application of an embodiment of the device for limiting the movement of one body in relation to another consistent with the teachings of the invention.

Figure 6 is another drawing of the example application of figure 5 of the device for limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

As shown in the drawings for purposes of illustration, the present patent document relates to a novel device for limiting the movement of one body in relation to another. In particular, a device is described which acts as an inexpensive interlock to limit movement of a body in relation to another. Such a device will be discussed in connection with its use in a tape library autochanger to inhibit complete removal of a drawer containing magnetic tape cartridges. For complete removal of the drawer, the interlock is easily released. Previous devices used as interlocks in such applications have relied upon expensive panel and/or computer actuated solenoids. The present patent document discloses a simpler, less expensive device. While the example shown is described in connection with a magnetic tape autochanger, the invention is not so limited.

In the following detailed description and in the several figures of the drawings, like elements are identified with like reference numerals.

Figure 1A is a drawing of a device **100** for limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention. In a first representative embodiment as shown in figure 1A, the device **100**, also referred to herein as lock spring **100** and as interlock **100**, comprises a piece **102** of material which could be fabricated as a wire **102**, a sheet stainless spring steel **102**, a band **102**, a molded part **102**, or the like. The piece **102** comprises first and second sections **105,110**. A distal portion of the first section **105** is referred to as a portion **145** in subsequent discussion.

In the un-deflected condition of figure 1A, a first angle **125** is formed between first and second sections **105,110** with vertex at first vertex **V1**. The first angle **125** is measured in a counter-clockwise direction from the first section **105**.

Figure 1B is a drawing of the device **100** of figure 1A located in a first position **215** for limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention. In the representative embodiment of figure 1B, the lock spring **100** shown is that of the first representative embodiment of figure 1A and is attached to a second body **210** at portion **145**. A first body **205** comprising a stop **212** is prevented from motion in a preselected direction **225** past the lock spring **100** by the impact of stop **212** against the second section **110**. In a typical application, the first body **205** is constrained to movement along an axis parallel to that of the preselected direction **225** by tracks attached to the second body **210**. With the lock spring **100** in the first position **215** as shown in figure 1B, the first body **205** is free to move in the direction opposite to the preselected direction **225** until restricted by other components of the second body **210** not shown in the figures. Also shown in figure 1B is a tool **230**, which could be, for example, a screwdriver **230**.

Figure 1C is another drawing of the device **100** of figure 1A located in a second position **220** for limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention. In figure 1C, the lock spring **100** has been moved to the second position **220** by a force applied by the tool **230** to the second section **110**. In the second position **220**, the second section **110** has been depressed far enough that it no longer impedes the movement of the

first body **205** past the second body **210**. The force required to move the lock spring **100** from the first position **215** to the second position **220** is preferably of a magnitude easily applied by hand and is, in some embodiments, less than one pound.

Practical minimum and maximum values for the first angle **125** are implementation-dependent. In general, however, characteristics of importance in the implementation are (1) for the lock spring **100** to impede, if not completely stop, motion of the first body **205** in the preselected direction **225** by impacting the stop **212**, (2) for the tool **230** to be capable of accessing the second section **110** in order to deflect it from the first position **215** to the second position **220** when removing the first body **205** from its position relative to the second body **210**, and (3) for the first body **205** to be able to move relatively freely in the opposite direction to that of the preselected direction **225** when replacing the first body **205** in position relative to the second body **210**. The specific materials chosen for the stop **212** and for the lock spring **100**, as well as the geometry chosen for the stop **212** will have a significant impact on the success in attaining the above important characteristics. A practical range for the first angle **125** is at least zero degrees and less than 135 degrees with typical, preferred value being 45 degrees.

Figure 1D is a drawing of another embodiment of the device **100** of figure 1A for limiting the movement of one body in relation to another with minimum value of first angle **125** consistent with the teachings of the invention. In figure 1D, the first angle **125** is equal to zero degrees.

Figure 2A is a drawing of another embodiment of the device **100** for limiting the movement of one body in relation to another consistent with the teachings of the invention. In a second representative embodiment as shown in figure 2A, the device **100**, also referred to herein as lock spring **100** and as interlock **100**, comprises a piece **102** of material which could be fabricated as a wire **102**, sheet stainless spring steel **102**, a band **102**, a molded part **102**, or the like. The piece **102** comprises first and second sections **105,110** and in addition a third section **115**. A distal portion of the first section **105** is referred to as the portion **145** in subsequent discussion.

In the un-deflected position of figure 2A, the first angle **125** is formed between

first and second sections **105,110** with vertex at first vertex **V1**. The first angle **125** is measured in a counter-clockwise direction from the first section **105**. Also, in the un-deflected position of figure 2A, a second angle **130** is formed between parallel translation of the first section **105** and the third section **115** with vertex at second vertex **V2**. The second angle **130** is measured in a counter-clockwise direction from the parallel translation of the first section **105**.

Figure 2B is a drawing of the device **100** of figure 2A located in the first position **215** for limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention. In the representative embodiment of figure 2B, the lock spring **100** shown is that of the second representative embodiment of figure 2A and is attached to the second body **210** at portion **145**. The first body **205** comprising the stop **212** is prevented from motion in the preselected direction **225** past the lock spring **100** by the impact of stop **212** against the second section **110**. In a typical application, the first body **205** is constrained to movement along an axis parallel to that of the preselected direction **225** by tracks attached to the second body **210**. With the lock spring **100** in the first position **215** as shown in figure 2B, the first body **205** is free to move in the direction opposite to the preselected direction **225** until restricted by other components of the second body **210** not shown in the figures. Also shown in figure 2B is the tool **230**, which could be, for example, the screwdriver **230**.

Figure 2C is another drawing of the device **100** of figure 2A located in the second position **220** for limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention. In figure 2C, the lock spring **100** has been moved to the second position **220** by force applied by the tool **230** to the third section **115**. In the second position **220**, the second section **110** has been depressed far enough that it no longer impedes the movement of the first body **205** past the second body **210**. For the second representative embodiment shown in figure 2A, the force used to move the lock spring **100** to the second position **220** is applied to the third section **115** or to the intersection of the second and third sections **110,115**.

Again practical minimum and maximum values for the first angle **125** are implementation dependent, as discussed in connection with the embodiments of figures 1A-1D. A practical range for the first angle **125** is at least zero degrees and less than 135 degrees with typical, preferred value being 90 degrees. A practical range for the second angle **130** is greater than or equal to 180 degrees and less than 270 degrees with typical, preferred value being 225 degrees.

Figure 2D is a drawing of another embodiment of the device **100** of figure 2A for limiting the movement of one body in relation to another with minimum value of first angle **125** consistent with the teachings of the invention. In figure 2D, the first angle **125** is equal to zero degrees and the second angle **130** is 180 degrees.

Figure 3A is a drawing of a further embodiment of the device **100** for limiting the movement of one body in relation to another consistent with the teachings of the invention. In a third representative embodiment as shown in figure 3A, the device **100**, also referred to herein as lock spring **100** and as interlock **100**, comprises the piece **102** of material which again could be fabricated as a wire **102**, sheet stainless spring steel **102**, a band **102**, a molded part **102**, or the like. The piece **102** again comprises the first, second, and third sections **105,110,115** and in addition a fourth section **120**. A distal portion of the first section **105** is referred to as the portion **145** in subsequent discussion.

In the un-deflected position of figure 3A, the first angle **125** is formed between first and second sections **105,110** with vertex at first vertex **V1**. The first angle **125** measured in a counter-clockwise direction from the first section **105**. Also, in the un-deflected position of figure 3A, the second angle **130** is formed between parallel translation of the first section **105** and the third section **115** with vertex at second vertex **V2**. The second angle **130** measured in a counter-clockwise direction from the parallel translation of the first section **105**. In addition, a third angle **135** is formed between parallel translation of the first section **105** and the fourth section **120** with vertex at third vertex **V3**. The third angle **135** is measured in a counter-clockwise direction from the parallel translation of the first section **105** at third vertex **V3**.

Figure 3B is a drawing of the device **100** of figure 3A located in the first position **215** for limiting the movement of one body in relation to another as described in various

representative embodiments consistent with the teachings of the invention. In the representative embodiment of figure 3B, the lock spring **100** shown is that of the third representative embodiment of figure 3A and is attached to the second body **210** at portion **145**. The first body **205** comprising the stop **212** is prevented from motion in the preselected direction **225** past the lock spring **100** by the impact of stop **212** against the second section **110**. In a typical application, the first body **205** is constrained to movement along the axis parallel to that of the preselected direction **225** by tracks attached to the second body **210**. With the lock spring **100** in the first position **215** as shown in figure 3B, the first body **205** is free to move in the direction opposite to the preselected direction **225** until restricted by other components of the second body **210** not shown in the figures. Also shown in figure 3B is the tool **230**, which could be, for example, screwdriver **230**.

Figure 3C is another drawing of the device **100** of figure 3A located in the second position **220** for limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention. In figure 3C, the lock spring **100** has been moved to the second position **220** by the force applied by the tool **230** to the fourth section **120**. In the second position **220**, the second section **110** has been depressed far enough that it no longer impedes the movement of the first body **205** past the second body **210**. For the third representative embodiment shown in figure 3A, the force used to move the lock spring **100** to the second position **220** is preferably applied to the fourth section **120**.

Practical minimum and maximum values for first, second, and third angles **125,130,135** are implementation dependent. In general, however, characteristics of importance in the implementation are (1) for the lock spring **100** to impede, if not completely stop, motion of the first body **205** in the preselected direction **225** by impacting the stop **212**, (2) for the tool **230** to be capable of accessing the fourth section **120** in order to deflect it from the first position **215** to the second position **220** when removing the first body **205** from its position relative to the second body **210**, and (3) for the first body **205** to be able to move relatively freely in the opposite direction to that of the preselected direction **225** when replacing the first body **205** in position relative to the

second body **210**. The specific materials chosen for the stop **212** and for the lock spring **100**, as well as the geometry chosen for the stop **212** will have a significant impact on the success in attaining the above important characteristics. In this embodiment, a practical range for the first angle **125** is at least zero degrees and less than 135 degrees with typical, preferred value being 90 degrees. A practical range for the second angle **130** is greater than or equal to 180 degrees and less than 270 degrees with typical, preferred value being 225 degrees. In addition, a practical range for the third angle **135** is greater than or equal to 135 degrees and less than 225 degrees with typical, preferred value being 180 degrees.

Figure 4A is drawing of still another embodiment of the device **100** for limiting the movement of one body in relation to another consistent with the teachings of the invention. In a fourth representative embodiment as shown in figure 4A, the device **100**, also referred to herein as lock spring **100** and as interlock **100**, comprises a base **150** which could be fabricated as a wire **102**, sheet stainless spring steel **102**, a band **102**, a molded part **102**, or the like. The base **150** comprises a first and second segments **160,165** and has a protrusion **155** attached to it. The protrusion **155** could be formed by any of various means including, but not limited to, the forming of a kink on the base **150** wherein the base is a wire. The protrusion **155** could also be extruded from the base **150** wherein the base is a strip of material. A distal portion of the first segment **160** will be referred to as an area **170** in subsequent discussion.

Figure 4B is a drawing of the device **100** of figure 4A located in the first position **215** for limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention. In the representative embodiment of figure 4B, the lock spring **100** shown is that of the fourth representative embodiment of figure 4A and is attached to the second body **210** at area **170**. The first body **205** comprising the stop **212** is prevented from motion in the preselected direction **225** past the lock spring **100** by the impact of stop **212** against the protrusion **155**. In a typical application, the first body **205** is constrained to movement along an axis parallel to that of the preselected direction **225** by tracks attached to the second body **210**. With the lock spring **100** in the first position **215** as shown in figure

4B, the first body **205** is free to move in the direction opposite to the preselected direction **225** until restricted by other components of the second body **210** not shown in the figures. A knowledge of these components is not necessary for an understanding of the invention. Also shown in figure 4B is the tool **230**, which could be for example screwdriver **230**.

Figure 4C is another drawing of the device **100** of figure 4A located in the second position **220** for limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention. In figure 4C, the lock spring **100** has been moved to the second position **220** by force applied by the tool **230** to the second segment **165**. In the second position **220**, the protrusion **155** has been depressed far enough that it no longer impedes the movement of the first body **205** past the second body **210**.

Figure 5 is a drawing of an example application of an embodiment of the device **100** for limiting the movement of one body in relation to another consistent with the teachings of the invention. Figure 5 shows the first body **205** which in this examples is the drawer **205** of an autochanger of a magnetic tape library used for data storage in computer systems. The drawer **205** contains a magazine tray **505** on which are loaded two tape magazines **510** each of which hold five tape cartridges **515** in this example. When the user desires to open the drawer **205**, he does so by first requesting it via either the front panel of the autochanger or via the host computer. His request may include the movement of a specific tape cartridge **515** with associated magazine tray **505** to the drawer **205**. The system then actuates a solenoid so that the drawer **205** can be partially opened providing access to the requested tape cartridge **515**. As previously described, the lock spring **100** preferably inhibits complete removal of the drawer **205**. For complete removal of the drawer **205**, the lock spring **100** is first released via insertion of the tool into an opening **520**.

Figure 6 is another drawing of the example application of figure 5 of the device **100** for limiting the movement of one body in relation to another as described in various representative embodiments consistent with the teachings of the invention. Figure 6 is a drawing of the detail indicated in figure 5. Figure 6 shows the lock spring **100** in first and second positions **215**,**220**. In the first position **215**, the impact of the stop **212** against

the second section **110** of the lock spring **100** prevents complete removal of the drawer **205** from the tape changer. To enable complete removal of the drawer **205**, the tool **230** is inserted into the opening **520** and then forces the lock spring **100** to rotate as indicated by rotation arrow **605** from the first position **215** to the second position **220**. Rotation is stopped by means of a rotation stop **610**. In the second position **220**, the second section **110** is moved such that it no longer impedes the movement of the drawer **205** with respect to the chassis **210** and can be completely removed from the autochanger chassis **210**.

A primary advantage of the embodiment as described in the present patent document over prior lock springs and interlocking mechanisms is its simplicity and the fact that it can be fabricated inexpensively.